The French Automated Speed Enforcement Programme: A Deterrent System at Work

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Abstract

During his presidential address in July 2002, President Chirac of France announced that traffic safety became a national priority. The French automated speed enforcement system (CA) was launched in November 2003. The implementation of CA permitted to strengthen the intensity of detection and to punish effectively speed offenders. Today roughly 1,850 speed radar devices are operating on the French road network.
The objectives of CA are in to change road users' driving choices by combining general deterrence and specific deterrence actions, and to build a consistent grid of detection on the whole territory for enforcing speed limits.
This paper presents some elements of understanding: a brief presentation of the CA, its organisation and its working. It will focus also on the impact of CA in terms of deterrence, by analysing the evolution of speed violation ratios and the effects on the mean speed.

Keywords

Speed, Speed Offences, Automated Speed Enforcement

Introduction

In 2003 French authorities began installing automated speed cameras on the national road network. This public-sector intervention represented a real break with past practice in several respects. Firstly in technological terms: an automated system based on a computer-led process of enforcement and sanctioning, and the use of digitisation. Secondly in political terms, with the crucial impetus provided by President Jacques Chirac putting an end to offender immunity via a system allowing for large-scale checking of driving speeds. Thirdly in administrative terms, with the introduction of a new system and new strategic and organisational configurations in the road safety field. And lastly, in terms of the road toll, with a significant decrease in the number of road accident victims.

The French CA (automated speed detection and sanction system) offers a substantial rise in deterrence and thus increased driver observation of speed limits. It increases both the probability of detection via a speed camera grid covering all of France and, by extension, the likelihood of being penalised. Full computerisation of the system ensures rapid legal treatment of offences and effective payment of fines.

This paper contains the results of a study focusing specifically on the CA's deterrent effect. The first section puts the subject into perspective by looking into the context of the system's implementation, its functioning, and the phases of its development seen in quantitative terms. The second section looks into the forms this policy of deterrence takes by making a distinction between mobile and fixed detection devices, and closes with comments on the strategy. The final section of the paper presents some general results, highlighting the impact of deterrence on driving speeds. An exploratory model is developed and its results presented in summary form. A consideration of the modes of deterrence open to the authorities completes this paper.

1 Context

The French automated speed enforcement programme represents a significant change in respect of deterring drivers from breaking the speed limit. Its organisation is innovative and implementation took place in stages [1].

1.1 Historical perspective

In his presidential speech of July 2002 Jacques Chirac announced the setting up of an automated speed enforcement programme on France's road network. Road safety became a national priority. The aim was to break with the road safety policy of the preceding years, which had never really been a prime government concern. What this change meant was the implementation of a determined road safety policy embodying a much more marked deterrence factor and more efficient application of the highway code.

Previously deterrence to speeding had been characterised by considerable leeway, widespread indulgence, random application of sanctions (with some cases having to be abandoned under the statute of limitations), and a low rate of payment of fines [2]. Even though new offences were defined and penalties increased in the late 1990s, notably in respect of highly excessive speeds and the introduction of possible prison terms for recidivists, the system of deterrence remained ineffective, as the relevant legal provisions were not – or only rarely – put into effect. This purely hypothetical application of speed limits undermined the credibility of measures taken by Police forces working with limited resources, and gave the offender good reason to consider any penalty as a form of injustice.

In 2002 over 7600 people met their deaths on French roads and the ONISR road safety observatory issued a figure of more than 137,000 injured. These statistics were unfavourably underlined by comparisons between France and other European countries [3]. Even if the adverse statistics cannot be totally explained by the policy of the time, lack of effective deterrence was doubtless a major contributing factor. This situation, then, called for forceful intervention overtly expressing an absence of fatalism where road safety was concerned and going counter to the powerlessness of previous years.

The official decision to establish an automated speed enforcement programme was something of a gamble, since it involved adopting a system both unpopular with drivers and intended to achieve significant results in the short term via deterrence and sanctions on a mass scale. However, the obtaining of a regular, substantial fall in the road toll, together with systematic media coverage, provided a protective shield for the CA in the event of criticism of the way the system functioned. This specific policy configuration also reinforced the government's choices in the area of deterrence and justified the ongoing installation of speed cameras throughout France. The number of road deaths fell by 40% between 2002–07.

Table 1 : Reduction of Road Fatalities in France

	2003/2002	2004/2003	2005/2004	2006/2005	2007/2006
Reduction (rate)	- 20.9 %	- 8.7 %	- 4.9 %	- 11.5 %	- 1.9 %
Reduction (number)	– 1511	- 499	- 258	- 570	- 94

(Source : ONISR)

Although the introduction of the CA certainly played a significant part in the reduction of the road toll over this period [4], the improved statistics cannot be explained solely in these terms. Yet the good results obtained mean that the new road safety policy has been systematically reduced to the CA programme and analysed via its functioning. The authorities, moreover, have contributed to this situation by regularly publicising the figures obtained by the CA: the system, they claim, was responsible for 75% of the fall in the number of road deaths in 2003–05 [5, p. 32]. However a more detailed assessment of the functioning of the CA is required if this initial estimate is to be confirmed.

1.2. How the system works

In setting up the CA system, the authorities also opted for a specific detection technology. The system is based on near-total automation of the detection and sanction procedures. The information collected by the different checking devices – fixed and mobile – is transmitted to the National Processing Centre (CNT) in Rennes, which computer-processes the information and draws up the documents necessary for prosecution of the offences detected. Thus the system is endowed with a massive capacity for processing material relating to speed limit infringements – the other side of the coin being that various legal changes were needed to cope. For one thing, detection of the offence was '*dematerialised*', as was the legal procedure itself. This means that the offender can pay his fine without having been in contact with a law officer, judge or representative of the state. However, even if the system hinges on cuttingedge technology and advanced automation of its procedures, the organisational side is not automated and calls for human intervention.

Thus it is that DPICA (Interdepartmental Automated Speed Detection Project) handles strategic functions (in the monitoring of the deployment and functioning of the system) and decision-making (in the deployment and sitting of the devices, signing of contracts, etc.). Headed up by a '*Préfet*' (prefect), this body also includes Police and Gendarmerie advisers, and analysts. The National Treatment Centre (CNT) includes, under the same roof, CACIR (Automated Centre for Observation of Traffic Offences), one of whose duties is to ensure observance of due process in respect of offences detected by the CA; and the associated companies responsible for processing incoming information, notifying offenders by mail, and ensuring payment of fines. CNT also monitors the actual running of the detection devices (cases of breakdown, vandalism, etc.). On the same site is the Infocentre (IFE), which provides the information needed for production monitoring and the establishment of indicators.

Operational management of mobile devices (in the deployment in the field, dispatching of information, etc.) is handled by the Gendarmerie and the National Police.[1] Providing these Police forces with automated speed-checking devices adds substantially to their surveillance capacity, but also requires regular availability of the necessary personnel, as well as in-the-field organisation of the system's use: choice of times and places, training of operators, etc. Thus providing small territorial units with an automated device can mean imposing a significant constraint: the need to use the device regularly can lead to heavy demand on limited personnel resources and thus hamper the effectiveness of such units in their other public safety and services to citizens. The result, then, can be a paradoxical situation. While automation is intended to free up resources, it can lead under certain circumstances to negative effects: whether to reduce the unit's room for manoeuvre in the public safety area or restrict the use of a costly piece of technology.[2]

1.3. Quantitative assessment

The first automated radar devices began to be used in November 2003. Over the period 2004–06 the authorities decided to accelerate deployment of the system and install 500 new devices every year, the aim being to reach a total of 1500 by the end of 2006. However, technical problems relating to installation and such administrative issues as tenders and contracts, slowed realisation of these aims, and the total reached was only 1100. In 2007, installation of a further 500 devices was agreed, and in December of that year it was announced that 1850 devices were operational.[3]

In addition, the CA's sphere of intervention was no longer limited solely to automated speed checking: devices designed to check interdistances and observance of red lights are also planned. When the 'Interministerial' (interdepartmental) Committee on Road Safety met in February 2008, the government announced the introduction of 2000 more devices by 2012, as part of a campaign to bring the annual number of road deaths down to 3000.[4]

At the end of 2007 the number of automated radar devices in use comprised 39% mobile and 61% fixed. Since the creation of the CA the authorities have been trying to adhere to a proportion of 1:3 unsignalled mobile devices, in the interests of specific deterrence, and 2:3 signalled fixed devices in the interests of overall deterrence. The intention is to combine a crackdown of enforcement with driver education.

Closer analysis of the deployment of checking devices between 2003–07 shows the existence of desynchronised phases for the installation of fixed and mobile devices. (Graph 1) Thus, the rate at which fixed devices (FR) were installed was relatively high in 2005 (+400), but was lower in 2006 and 2007 (+210 and +270 respectively). In the case of mobile devices (MR), deployment was high in 2005 (+217) and 2007 (+335). Thus the real rise of the CA took place during 2005, that is to say over a year after its official launch. Its growth accelerated during 2007 largely because of the addition of mobile devices. This figure must be considered in relation to changes in the road toll, which began falling markedly in 2003; this justifies further investigation of the deterrent effect of the CA and the existence of this disparity.

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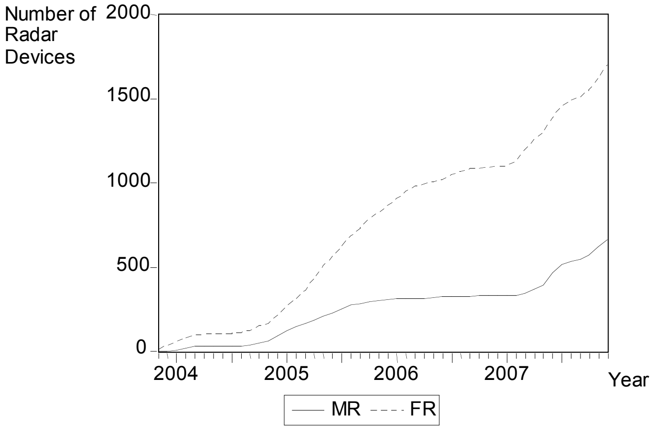
[1] France has two national Police forces: the National Police, which is the main civil law enforcement agency, with primary jurisdiction in cities and large towns; and the military Gendarmerie, with primary jurisdiction in smaller towns and rural areas.

[2] Interview carried out on 28 April 2008 with a high-ranking officer of the Gendarmerie Nationale.

[3] Information provided by DPICA in April 2008.

[4] Press kit from the 'Interministerial' (Interdepartmental) Committee for Road Safety, 13 February 2008, 22 pp.

Graph 1: Increase in the number of automated radars devices in France (2004-2007)



(Source: DPICA 2008)

2 Initial analysis of CA deterrence production

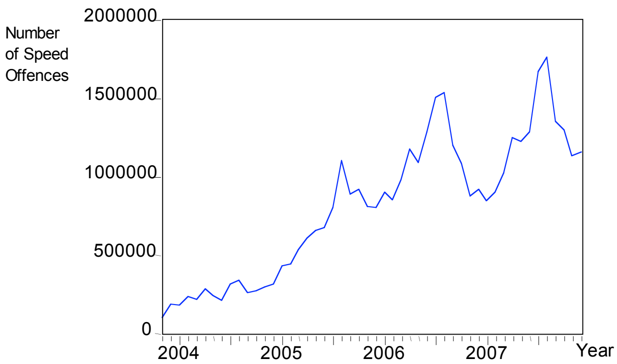
The CA has brought a substantial increase in the capacity to check driving speeds and detect infringements. An analysis in terms of production highlights the reaching of a saturation point [6, p.6] and allows for the drawing of a number of strategic lessons.

2.1. Increased surveillance of drivers

In 2007 some 14.7 million infringements were signalled by messages from the automated speed checking system.[5] These messages indicate that the apparatus in question has been triggered and taken a photograph of a speed limit offender. (Graph 2) However, such a message is not necessarily followed by the imposing of a fine. Some of the photographs prove unusable for various reasons – illegible number plates, presence of several vehicles, vehicles registered outside France – and consequently the message does not give rise to legal action.

Analysis of this series confirms and underscores the increase in the extent of the system during 2005, and its continuation until mid-2006. Since then the system's production has been fairly stable, despite the installation of new apparatuses. The series also reveals peaks during summer: this can be explained by the higher number of journeys on parts of the road network where users are more or less unfamiliar with checking points.

Graph 2: Number of speed offences detected by automated radars devices in France (2004-2007)



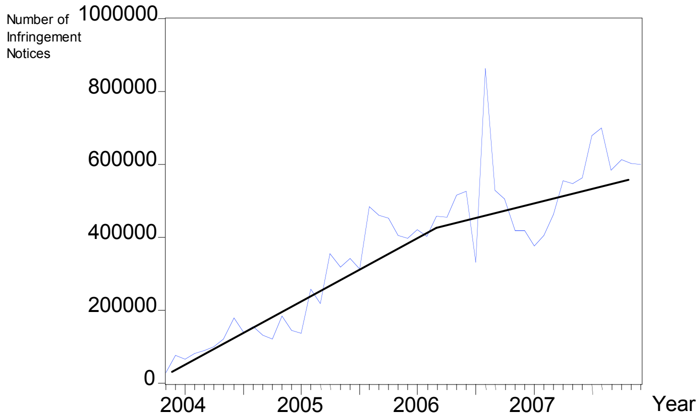
(Source: DPICA 2008)

[5] Data provided by DPICA, April 2008.

Over the period 2003–07, some 18 million speed limit infringements were registered by the automated system. A speed offender has to pay a fine and suffers from a loss of points on his driving licence. Given that the number of driving licences in France is around 40 million, this means that on average the CA led to 15% of drivers being charged with speeding in 2007. Moreover massive detection of offenders also has produced a closely connected effect in the form of increased driving by persons whose licenses have been suspended. In 2006 almost 69,000 licenses were cancelled. These figures highlight the impact of the deployment of this kind of system on society.

Analysis of the changing number of fines recorded by the CA confirms the observation of the number of infringements detected. (Graph 3) The decline in the rate of increase of fines imposed begins early in 2006 – despite the presence of more devices. The number of fines increased by 290% between 2004 and 2005, by 41.5% between 2005 and 2006, and only by 14% between 2006 and 2007.

Graph 3: Number of Infringement Notices issued by the CA in France (2004-2007) (in thousands)

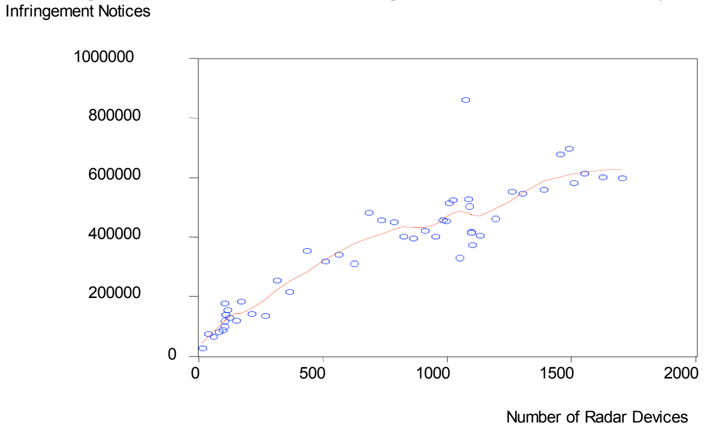


(Source: DPICA 2008)

2.2. Decreasing marginal returns and average production: an economic analysis of the production of the deterrent device.

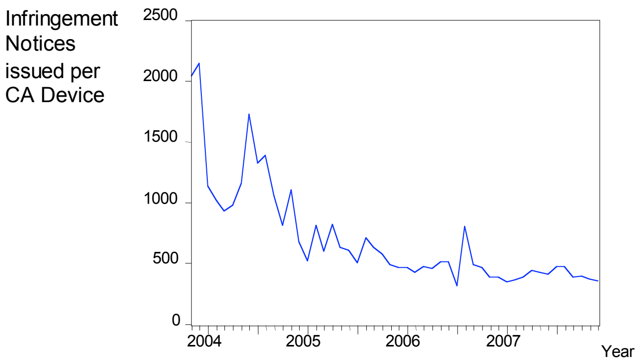
Well known to economists who analyse productive phenomena and entrepreneurial activity, the law of decreasing marginal returns states that beyond a given point, in a production system with fixed and variable inputs, each additional unit of variable input yields less and less additional output [7, p. 162 and ff.]. If we take the CA as giving rise to a kind of production – fines imposed, for instance – with the number of checking devices constituting the associated production factor, the marginal increase in the number of fines imposed during ongoing deployment of the device is necessarily going to diminish. Graph 4, which brings together the number of fines imposed by the CA and the number of devices being put into service, confirms the predictions of this law. Thus it would seem that the system has reached saturation point. This means that, all things being equal, the number of fines imposed will increase only slightly despite the increase in the number of devices. The threshold will stabilise at somewhere between 600,000 and 650,000 fines monthly, i.e. an annual total of between 7.2 and 7.8 million, while the figure for 2007 was 6.7 million. This fall in the productivity of the deterrent device indicates that gains in terms of damage avoided and lives saved will become harder and harder to obtain. In the future, then, a fixed decrease in the number of victims will demand proportionately greater resources.

Graph 4: Marginal Return for the Infringement Notices issued by CA



Examination of average productivity for each type of device – defined as the total number of infringements registered per device – allows us to refine this initial analysis. Average productivity has been dropping steadily since the system came into force. For 2007 this average productivity was around 400 infringements per month (average per operational device over one full year[6]). (Graph 5) We should, however, make a distinction between the productivity of fixed devices (315) and that of mobile ones (568). Average productivity of mobile apparatuses is 80% higher than that of fixed ones. This difference can doubtless be largely explained by the fact that the presence of mobile devices is not signalled, this making it harder for drivers to spot them.

Graph 5: Average Return of Radars Devices
(Infringement Notices (IN) issued by CA per device)



The analytical approach consisting of presenting the imposing of fines as a productive activity (in the sense that a productive structure exists) that varies in line solely with the variation of a specific production factor, must be reconsidered in the light of the lessons to be learnt from economic analysis of crime [8]. The goal of the checking system is to produce deterrence, i.e. to deter the driver from breaking the speed limit. An increased effort at detection means that the potential sanction (probability of being caught × possible sanction) also increases, which must lead to a reduction in the number of offences committed. In consequence the total number of sanctions depends positively on the intensity of detection efforts (number of devices installed *(q)*) and negatively on the behavioural response of drivers*(c(q))* to the increase in detection *(q)*. As a result, average productivity in terms of sanctions per apparatus increases if the effect associated with the increased detection capability is greater than that of the deterrence. The

[6] The total number of checking devices on 31 December of a given year does not signify that all of them have been functioning all year. A device installed in July of that year will be considered as a unit in the calculation of the total, while it will be considered in functional terms as a half-unit. My analysis here is based on functioning and does not cover the actual availability of the devices (breakdowns and vandalism in the case of fixed devices, duration of use for mobile ones). This is because the relevant information had not been provided.

effect in terms of volume must be greater than that in terms of value. Average productivity decreases when, all things being equal, the deterrent effect is greater, which would seem to be the case with the CA system.

2.3. Some strategic lessons

Analysis in terms of average productivity can be honed by making a distinction between the kinds of devices used. The authorities opted for fixed devices as a means of producing overall deterrence. As part of this approach, the checking points are appropriately signalled in advance and are also listed on special Internet sites. Analysis of the average productivity of fixed devices reveals a rapid, steady decrease: where the figure was once around 1450 monthly violations per device, by 2007 it had dropped to 315. This rapid decline can be explained both by the deterrent effect – simultaneously linked to the high level of visibility of the fixed devices and the impressive territorial coverage they represent –and by drivers' ability to learn to spot checking points and foil the devices [9; 10 ; 11]. So what is needed here is closer study both of the effects associated with driver behaviour – the strategy ultimately adopted – and the spatial and temporal halo effects [12]. Other research stresses that fixed devices mainly produce local deterrence [13, p. 20]. The territorial coverage allowed by the sheer number of devices doubtless helps produce a broad – but limited – deterrence effect. It could be said that use of fixed apparatuses has reached the limits of its efficiency.

Deployment of mobile devices obeys a different rationale: that of producing specific deterrence. For the authorities the goal is to establish an effective, retributive policy. Average productivity for mobile devices remains steady at around 560 violations per month. The fact of not being signalled makes the checks in a sense random and hard to predict. This prevents drivers from modifying their behaviour and easily eluding the checking device. The randomness of these checks and their increasing use doubtless explain the steadiness of productivity. Another theory has it that the mobile device enables detection of the drivers the most inclined not to observe speed limits; if accurate, this would underscore that the two enforcement modes are complements,[7] and would also indicate a residual deterrence capacity on the part of the system. At the same time, for these devices to be optimally effective, attention must be given to the way they are used by Police forces.

3. Initial analysis of the deterrent effect of the CA on driving speeds

The French authorities possess statistical information pointing to a significant fall in driving speeds and a marked shift in drivers' choices regarding speed. Modelling of the deterrent effect shows the impact of the CA on driving speeds and the number of speed limit violations. This deterrent effect could be reinforced in the future via identifiable sources of deterrence.

3.1. General assessment

Examination of the changes in average speeds, regardless of the road network and type of vehicle, points up a marked drop since 2002 [2]. The overall average speed indicator drawn up by ONISR was 81.6 kph in the third quarter of 2007, whereas it was 90.5 kph in the first quarter of 2002.[8] Over the same period the average speed of private cars decreased by 10% on freeways (118.9 kph), by almost 13% for secondary roads (84.8 km/h), and by some 12% (80.4 kph) on main roads.

Significant results have also been obtained regarding the level of excess speed for each type of vehicle over the same period. The rate of infringements of more than 10 kph over the speed limit has fallen by 56% for private cars, by more than 33% for motorcycles and by 36% for trucks. In addition extreme speeding excesses (30 kph over the speed limit) are now much fewer, representing less than 1% of all speed limit violations in 2007.

Without going into changes in speed habits in any further detail, it is important to look at the origins of this significant decrease. Interestingly, the drop in traffic speeds began during 2002, whereas the speed enforcement programme took effect in the last third of 2003. Thus half the gains identified by

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[7] What would be interesting here is information regarding the levels of excess speed registered by fixed and mobile devices. A comparison would then be possible and categories of offenders could thus be determined.

[8] Observatoire National Interministériel de Sécurité Routière, *Observatoire des vitesses,* n°17, mars 2008. www.securiteroutiere.gouv.fr/observatoire.

the average speed indicator were obtained before the CA became operational. Only the gains for motorcycles came later, doubtless obtained thanks to an appropriate generation of speed cameras.

How, then, can this significant drop in speed be explained? Can it be put down to an anticipation effect triggered by president Chirac's speech and the subsequent decisions handed down by interministerial (indepartmental) committees? If so, implementation of the CA then reinforced this initial effect with further drops.

Recent increases in fuel prices have certainly contributed to the nationwide fall in driving speeds by changing driving habits: excessive fuel consumption caused by faster driving has become more expensive [14]. The rise in fuel prices has doubtless induced some drivers to opt for lower speeds by squeezing their budgets. Thus this effect must have contributed to the overall decrease in driving speeds [15].

3.2. An attempt at modelling

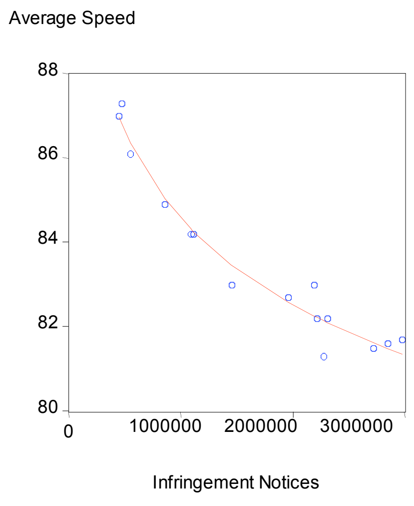
The proposed model presupposes that the driving speed choices being made throughout the country hinge on the effectiveness of the automated enforcement system both fixed (FIX) and mobile (MOB), on traditional Police methods (TRA) and the price of fuel (FUE). The deterrence variables are defined as the logarithm of the number of violations produced by each device. (CSA) includes the automated system as a whole (FIX + MOB), while (CA) designates the overall attempts at deterrence (CSA + TRA). The fuel price variable represents a weighted index of the price of diesel and petrol (according to their consumption level). Each variable must act negatively on the variables of driving speed *(V)*, as it pushes up the cost of higher speed. The speed variables are the synthetic index of the average speed *(AS)*, the rate of speed limit violation for private cars *(SE)* and the percentage of speed excess higher than 30 kph *(HSE)*.

Thus the model can be written as follows:

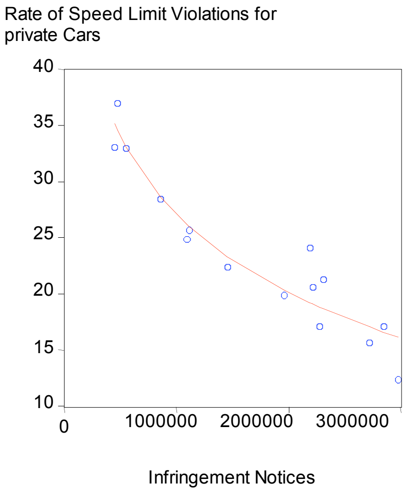
$$V_t = c + FIX_t + MOB_t + TRA_t + FUE_t + u_t \qquad (1)$$

This model is relatively crude in that it relies on a limited number of variables and a small sample. Quarterly data available for the period 2003–07 has been used for this paper. The data relating to speed were generously provided by ONISR and those concerning the enforcement system by DPICA. Nonetheless the model fits with the approach used in earlier research modelling the relationship between the intensity of road safety surveillance and speed choices [16]. Graphs 6, 7 and 8 illustrate the close correlation between the different speed indicators and the attempts at deterrence.

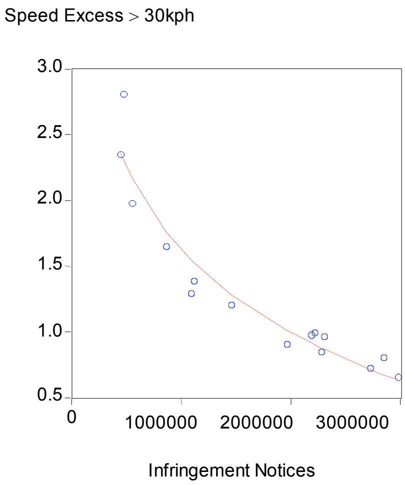
Graph 6: Correlation between the Average Speed and the number of Infringement Notices issued by the CA



Graph 7: Correlation between the Rate of Speed Violations for Privates Cars and the Number of the Infringement Notices issued by CA



Graph 8: Correlation between the Rate of Speed Violations for Privates Cars and the Number of the Infringement Notices issued by CA



The explanatory average speed model shows the existence of a "basic traffic speed" of around 90 kph, thus confirming the results of earlier studies [17 ; 18]. The variables as a whole behave as expected: they act negatively on the average speed. The rise in fuel prices pushes up the cost of fast, fuel-consuming driving and this leads to a reduction in average driving speeds. The fact remains, however, that this effect is of little significance from a statistical point of view.

The effects of the deterrent variables on speed fit with the theory. A higher level of Police enforcement leads to slow traffic speeds. The deterrent effect of the CA (making no distinction between mobile and fixed devices) is significant. When the effects are separated according to the type of device, the mobile variant produces the most marked deterrence. By contrast, traditional enforcement methods seem to have little effect on average driving speeds. When the deterrent system is considered as a whole, the deterrent effect is the highest of the three suggested regressions, while the fuel variant becomes positive! Regarding this last regression, the deterrent variable would seem to capture part of the gains linked to fuel prices.

This first regression suggests the different enforcement devices are complements. Their interaction increases the total deterrent effect. It also underscores the effectiveness of the French strategy of intelligent policing based on a complementary-modalities division of labour, within which traditional enforcement appears to play an important backup role.

When the explanatory variable is that of the percentage of drivers exceeding the speed limit *(SE)*, the preceding results can be refined. The regressions emphasise the vital role of mobile devices in the deterrence process. The fixed devices and traditional enforcement methods present effects that are of little significance statistically. There is behavioural adaptation on the part of drivers who, once they know where fixed devices are located, can foil them by slowing down at the checking point and then speeding up again. The halo effect is restricted to a few hundred metres around the checking point [4, p. 3]. It would also be a good idea to examine Police practices in respect of traditional enforcement: do margins of tolerance persist and if so, to what extent? The model confirms the impact of the enforcement device, which thus fulfils its purpose by deterring potential offenders. And once again it confirms that the different checking strategies are complements.

The results for the model explaining very high excess speeds *(HSE)* (30 kph above the speed limit) converge as they advance. The fuel variable plays a significant part in offender behaviour, and traditional enforcement also contributes to the deterrent process. Thus the effect of the CA is also confirmed. Fixed devices seem a more effective deterrent than mobile ones, with the large number of devices in operation throughout the country having a calming effect on driving practices. Interaction between automated and traditional enforcement seems essential if the deterrent effect is to be heightened, as it enables close gridding of the road network, multiple modalities and numerous enforcement points. The margin of tolerance effect no longer seems to play a part in relatively extreme speed infringements.

To sum up these initial, exploratory results: the model confirms the deterrent effect of the CA with different effects according to the type of devices (fixed or mobile) and the type of offender. Given that its use is signalled and currently applies to the entire national territory, the fixed device crucially allows for a calming effect on driving behaviour (i.e. on average driving speeds) and an influence on drivers prone to extreme violations of the speed limit. A deterrent effect on offenders has also been identified in respect of mobile devices, which seem particularly useful in the case of infringements of less than 30 kph. Their impact on major speed violations is real, but they do not appear to be the most appropriate modality. In fact this result needs to be used prudently, for the recent increase in the use of this modality and the ongoing establishment of usage protocols by the Gendarmerie may lead to modification of these initial conclusions. Traditional methods appear to be a vital component of overall enforcement. Their deterrent effect has been identified, even if it is not always statistically significant. In consequence these initial results militate in favour not only of maintaining current combination of speed enforcement strategies, but also of drawing up real strategic emphases for definition of an intelligent policing policy. These are the necessary preconditions for a significant, lasting effect on road user behaviour choices.

The different speed enforcement strategies raise a number of questions regarding the importance of deploying visible enforcement devices – fixed and signalled automated apparatuses, and the traditional method using identifiable vehicles – and the extent of such deployment; and others concerning the need for maintaining the personal contact with offenders that is only possible via traditional methods involving direct interception. Research exists which stresses the need to take account of drivers' perception of the likelihood of being caught as part of their decision-making [6, p. 11-12]. Also needed is closer study of the impact of enforcement modalities and visibility on driver choices [19], together with the consequences for the functioning of the automated system. Other investigations related to the impact of in-car GPS equipment enabling to give the position of fixed radars could also improve the speed enforcement policy.

3.3. Sources of deterrence

Both production analysis of the CA system and the proposed econometric model bring to light a real deterrent effect on speeds practised, speeding violations, and extreme speed excesses. Do other sources of deterrence exist? In other words, do the authorities have room to move in terms of improving the deterrent effect of the system they are in charge of?

An initial source exists in relation to improving the quality of the system's output. Even if the devices have provided some 14.7 million infringement messages, only 6.98 million fines have been imposed. Overall, then, only 47% of the violations registered result in legal action. Improvement of the quality of the photos is thus a major potential source of increased deterrence, given a constant number of devices. The authorities are currently working on improvements to the system's operational quality and to this end have undertaken a quality control approach.

A second potential means of increasing deterrence consists in improving the device's detection ability and the capacity to take action against offenders. Part of the current stock of operational devices only takes photos of approaching vehicles, a method which de facto excludes detection of speeding motorcycles, as the latter have a single number plate attached to the rear. The introduction of a new generation of devices which takes photos from behind – and thus registers the rear number plate – now means that offenders in this category can be identified. This development should be accelerated, as it will lead not only to increased effectiveness but also to equitable treatment for all road users. Another avenue to be followed up is proceedings against foreign drivers, who at present enjoy immunity: legal action is restricted to France's national territory. Bilateral negotiations are now under way with the countries on France's borders, with a view to putting an end to this situation. Like the first resource, this one hinges on improvements to the devices without necessitating any increase in their number.

The third source involves maintaining traditional enforcement while bolstering its effectiveness. Automated checks and the use of Police officers to implement them should not be to the detriment of these methods. There is much to be learnt from the British situation in this respect [20]. A distinctive characteristic of the French situation has to do with the relationship between the automated and the traditional enforcement: they are complements. Personnel must be maintained at current levels, their equipment improved, and their deployment in the field angled towards violations whose detection cannot be automated. This relationship would thus enable intelligent traffic policing, as it is based on an appropriate division of labour with implications going beyond the sole issue of speeding infringements.

A fourth source hinges on the strategic emphases of the automated system, one of which is the signalling of the location of checking devices. Should such signalling be done away with completely or extended to all devices? At present France has no definitive answer to this question. A useful approach here would be to look into the alternative choices of signalling – a specific place? a zone? a signal before or after the checking point? – as these could constitute an intermediate response falling between total signalling or elimination of all signals [13]. Australian enforcement programmes raise interesting possibilities in this regard. Another adjustment feasible for the authorities would involve modifying the makeup of the stock of detection devices. If their aim is to escalate the punitive aspect of the system, they could opt for increasing the number of mobile devices. However, such a decision would call for consideration of the organisational consequences for the Police forces in charge of operational implementation. The authorities have to come to terms with a form of interdependence founded on a subtle balance between the educative and the punitive on the one hand, and completely automated, independent modalities and action requiring the cooperation of external organisations on the other. This balance has led to a form of consensus resulting from a trade-off between the social acceptability of the system and its effectiveness as deterrence. Improvement of this deterrence must be sought without leading to loss of its social legitimacy and to the destabilising of the system.

Conclusion

The automated speed enforcement system, established in France, during 2003 represents a determination on the part of the authorities – with broad public support – to break with past practice in policy terms. One of the intentions was increased respect for the victims of road accidents and their families in situations in which the person responsible – the killer in some cases – too often went unpunished. The issue, then, was justice. Deployment of the system quickly resulted in favourable road safety statistics which confirmed the authorities' belief that they had made the right choice.

The institutional organisation of the CA – various ministries and the public and private sectors working together – and its working characteristics point to an innovative enforcement programme which many other countries with similar aims have taken as their inspiration. What seems absolutely necessary now is a detailed international comparison between the different systems – including Australian speed control programmes – in the interests of identifying their institutional diversity and best practices.

This paper proposes an innovative analysis in that it focuses on the production aspect of deterrence. This has brought out a number of lessons and raised various strategic issues. The effect on driving speeds and observance of speed limits are clearly established. However, much remains to be done, especially in respect of identifying the system's impact on the road toll.

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Appendix

Dependent Variable: AS
Method: Least Squares
Included observations: 15

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	108.6646	44.72000	2.429888	0.0334
LTRA	-1.029194	3.381767	-0.304336	0.7666
LCSA	-0.073358	0.025055	-2.927863	0.0137
FUE	-0.073413	0.011467	-6.402032	0.0001

R-squared	0.925254	Mean dependent var	83.52667
Adjusted R-squared	0.904869	S.D. dependent var	2.010496
S.E. of regression	0.620104	Akaike info criterion	2.105320
Sum squared resid	4.229824	Schwarz criterion	2.294134
Log likelihood	-11.78990	F-statistic	45.38839
Durbin-Watson stat	2.067922	Prob(F-statistic)	0.000002

Dependent Variable: AS
Method: Least Squares
Included observations: 15

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	39.68167	59.77132	0.663891	0.5218
LTRA	4.002123	4.434734	0.902449	0.3880
LMOB	-0.070034	0.043939	-1.593903	0.1420
LFIX	-0.042612	0.028316	-1.504848	0.1633
FUE	-0.050769	0.017976	-2.824313	0.0180

R-squared	0.942624	Mean dependent var	83.52667
Adjusted R-squared	0.919673	S.D. dependent var	2.010496
S.E. of regression	0.569815	Akaike info criterion	1.974191
Sum squared resid	3.246891	Schwarz criterion	2.210208
Log likelihood	-9.806436	F-statistic	41.07194
Durbin-Watson stat	1.950658	Prob(F-statistic)	0.000004

Dependent Variable: AS
Method: Least Squares
Included observations: 15

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	133.5596	4.848557	27.54625	0.0000
LCA	-3.876466	0.517208	-7.494978	0.0000
FUE	0.032880	0.017754	1.852029	0.0888

R-squared	0.972586	Mean dependent var	83.52667
Adjusted R-squared	0.968017	S.D. dependent var	2.010496
S.E. of regression	0.359552	Akaike info criterion	0.968940
Sum squared resid	1.551331	Schwarz criterion	1.110550
Log likelihood	-4.267052	F-statistic	212.8675
Durbin-Watson stat	2.665197	Prob(F-statistic)	0.000000

Dependent Variable: SE
Method: Least Squares
Included observations: 15

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	287.2235	223.6431	1.284294	0.2254
LTRA	-16.90569	16.91210	-0.999621	0.3390
LCSA	-0.156838	0.125300	-1.251701	0.2366
FUE	-0.275483	0.057347	-4.803820	0.0005

R-squared	0.846732	Mean dependent var	23.52000
Adjusted R-squared	0.804931	S.D. dependent var	7.021416
S.E. of regression	3.101120	Akaike info criterion	5.324582
Sum squared resid	105.7864	Schwarz criterion	5.513395
Log likelihood	-35.93436	F-statistic	20.25652
Durbin-Watson stat	1.835615	Prob(F-statistic)	0.000087

Dependent Variable: SE
Method: Least Squares
Included observations: 15

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	56.28711	9.056487	6.215115	0.0000
LMOB	-0.251417	0.113827	-2.208769	0.0474
FUE	-0.207528	0.065054	-3.190081	0.0078

R-squared	0.844910	Mean dependent var	23.52000
Adjusted R-squared	0.819062	S.D. dependent var	7.021416
S.E. of regression	2.986686	Akaike info criterion	5.203062
Sum squared resid	107.0435	Schwarz criterion	5.344672
Log likelihood	-36.02297	F-statistic	32.68730
Durbin-Watson stat	1.814059	Prob(F-statistic)	0.000014

Dependent Variable: SE
Method: Least Squares
Included observations: 15

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	200.3978	29.19518	6.864072	0.0000
LCA	-13.96995	3.114327	-4.485705	0.0007
FUE	0.141557	0.106902	1.324169	0.2101

R-squared	0.918506	Mean dependent var	23.52000
Adjusted R-squared	0.904924	S.D. dependent var	7.021416
S.E. of regression	2.165012	Akaike info criterion	4.559585
Sum squared resid	56.24731	Schwarz criterion	4.701195
Log likelihood	-31.19689	F-statistic	67.62528
Durbin-Watson stat	2.092007	Prob(F-statistic)	0.000000

Dependent Variable: HSE
Method: Least Squares
Included observations: 15

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	13.64415	13.91261	0.980704	0.3478
LTRA	-0.703970	1.052084	-0.669120	0.5172
LCSA	-0.032589	0.007795	-4.180858	0.0015
FUE	-0.018781	0.003567	-5.264592	0.0003

R-squared	0.927071	Mean dependent var	1.306667
Adjusted R-squared	0.907181	S.D. dependent var	0.633219
S.E. of regression	0.192917	Akaike info criterion	-0.229931
Sum squared resid	0.409388	Schwarz criterion	-0.041117
Log likelihood	5.724480	F-statistic	46.61065
Durbin-Watson stat	2.462679	Prob(F-statistic)	0.000002

Dependent Variable: HSE
Method: Least Squares
Included observations: 15

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-5.703469	18.05077	-0.315968	0.7585
LTRA	0.707867	1.339277	0.528544	0.6087
LMOB	-0.019375	0.013269	-1.460123	0.1749
LFIX	-0.024175	0.008551	-2.827018	0.0179
FUE	-0.012534	0.005429	-2.308947	0.0436

R-squared	0.947248	Mean dependent var	1.306667
Adjusted R-squared	0.926148	S.D. dependent var	0.633219
S.E. of regression	0.172082	Akaike info criterion	-0.420484
Sum squared resid	0.296124	Schwarz criterion	-0.184467
Log likelihood	8.153630	F-statistic	44.89177
Durbin-Watson stat	2.402138	Prob(F-statistic)	0.000002

Dependent Variable: HSE
Method: Least Squares
Included observations: 15

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	19.64986	1.918595	10.24180	0.0000
LCA	-1.525613	0.204662	-7.454321	0.0000
FUE	0.022001	0.007025	3.131779	0.0087

R-squared	0.956728	Mean dependent var	1.306667
Adjusted R-squared	0.949516	S.D. dependent var	0.633219
S.E. of regression	0.142276	Akaike info criterion	-0.885236
Sum squared resid	0.242910	Schwarz criterion	-0.743626
Log likelihood	9.639273	F-statistic	132.6570
Durbin-Watson stat	1.891243	Prob(F-statistic)	0.000000